



Technical Standard Order

Subject: TSO-C142, LITHIUM BATTERIES

- 1. PURPOSE.** This technical standard order (TSO) prescribes the minimum performance standard that lithium cells and batteries must meet to be identified with the applicable TSO marking.
- 2. APPLICABILITY.** The standards of this TSO apply to lithium cells and batteries intended to provide power for aircraft equipment including emergency and standby systems. The RTCA Inc. (RTCA) Document No. DO-227, "Minimum Operational Performance Standards for Lithium Batteries," dated June 23, 1995, contains both requirements and guidance covering chemical composition, quantity of potentially hazardous substances, cell size, cell construction, interconnection of cells into batteries, fusing, venting, current limiting, operational and storage environments, packaging, handling, tests, and disposal which affect the use of these articles in aircraft.
- 3. REQUIREMENTS.** Lithium batteries that are to be so identified must meet the standards set forth in RTCA/DO-227, Section 2.0.
 - a. Failure Condition Classification.** Failure of the function defined in paragraph 2 of this TSO has been determined to be major failure condition. The applicant must develop batteries which will provide at least a design assurance level commensurate with this failure condition classification.
 - b. Environmental Qualification.** Lithium cells or batteries shall be subject to the test conditions as specified in RTCA/DO-227, Section 2.3.
- 4. MARKING.** Each lithium cell or battery must be marked in accordance with 14 CFR 21.607(d) and RTCA/DO-227, Section 1.4.6.
- 5. DATA REQUIREMENTS.**
 - a. Data to be provided with the application.** In accordance with 14 CFR 21.605 (a), the manufacturer must furnish the Manager, Aircraft Certification Office (ACO), Federal Aviation Administration (FAA), having purview of the manufacturer's facilities, one copy of the following technical data to support the FAA design and production approval:

(1) Operating instructions and battery limitations. The limitations shall be sufficient to describe the operational capability of the battery.

(2) Installation procedures and limitations. The limitations shall be sufficient to ensure that the battery, when installed in accordance with the installation procedures, continues to meet the requirements of this TSO. The limitations shall include the following statement: "The conditions and tests required for this TSO approval of this battery are minimum performance standards. It is the responsibility of those desiring to install this battery in a specific class of aircraft to determine that the aircraft installation conditions are within the TSO standards. The battery may be installed only if further evaluation by the applicant documents an acceptable installation and is approved by the Administrator. Lithium battery safety concerns include the possibility of fire, venting violently, and venting of toxic gases.

(3) Schematic drawings as applicable to the installation procedures.

(4) Wiring diagrams as applicable to the installation procedures.

(5) Specifications.

(6) List of components by part number.

(7) Instructions for periodic maintenance and calibration which are necessary for continued airworthiness once the equipment is installed.

(8) An environmental qualification form describing the environmental tests that were conducted in accordance with RTCA/DO-227, Section 2.3.

(9) Manufacturer's TSO qualification test report.

(10) Nameplate drawing.

(11) A drawing list, enumerating all of the drawings and processes that are necessary to define the article's design.

b. Data that must be available upon request. In addition to those data requirements that are to be furnished directly to the FAA, each manufacturer must have available for review by the manager of the ACO having purview of the manufacturer's facilities, the following technical data:

(1) The functional qualification specifications to be used to qualify each production article to ensure compliance with this TSO.

(2) Equipment calibration procedures.

(3) Corrective maintenance procedures (within 12 months after TSO authorization).

(4) Schematic drawings.

(5) Wiring diagrams.

(6) The results of qualification tests conducted in accordance with RTCA/DO-227, Section 2.0.

c. Data to be furnished with manufactured units. One copy of the data and information specified in paragraphs 5a(1) through (8) must go to each person receiving for use one or more batteries manufactured under this TSO.

6. AVAILABILITY OF REFERENCE DOCUMENTS.

a. Copies of RTCA Document No. DO-227 may be purchased from the RTCA Inc., 1140 Connecticut Avenue, NW, Suite 1020, Washington, D.C. 20036-4001.

b. Federal Aviation Regulations Part 21, Subpart O, may be purchased from: Superintendent of Documents, Government Printing Office, Washington, DC 20402-9325.

c. Advisory Circular 20-110 (current revision), "Index of Aviation Technical Standard Orders," may be obtained from: U.S. Department of Transportation, Subsequent Distribution Office, Ardmore East Business Center, 3341 Q 75th Avenue, Landover, MD 20785.



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APPENDIX 1. MINIMUM PERFORMANCE STANDARD FOR LITHIUM BATTERIES

1. PURPOSE. This appendix prescribes the MPS for Lithium Batteries as modified by the FAA for reference in this TSO.

2. REQUIREMENTS. The standards applicable to this TSO are set forth in the industry standard specified in paragraph 3 of this TSO. The applicable standard, RTCA/DO-227, Minimum Operational Performance Standard for Lithium Batteries, dated June 23, 1995, is modified as follows:

a. Exceptions.

(1) Delete the superscript "4" on the Internal Short-Circuit Test row under the "FIRE" column in **Table 2-1**. The superscript "4" is only used under the Forced-Discharge, External Short-Circuit, and Charging Test tests and then only under the "LEAK" and "VENT" columns.

(2) Replace **Figure 2-3** and **Figure 2-4** with the modified vibration Figure 2-3 and Figure 2-4 respectively shown in APPENDIX 2 of this TSO. These figures depict clearer limit lines.

(3) In lieu of the wording in paragraph 2.3.2, **Shock Test**, substitute the following:

"For the battery shock test, samples should be mounted in the equipment in which they will be used.

This test is performed using undischarged sample cells or batteries. Secure the sample to a shock table by a mechanically secured device. The shock test machine must be capable of imparting to the sample a series of calibrated shock impulses. The shock impulse waveform distortion at any point on the waveform may not be greater than 15 percent of the peak value of the shock pulse. The duration of the shock pulse is specified with reference to the zero points of the wave. The shock forces are specified in terms of peak amplitude g values.

The shock impulse must be measured using a calibrated accelerometer and associated instrumentation having a 3db response over a range of at least 5 to 250 Hz. Mount the sample on the shock test machine so that the shock impulses can be applied in both directions of the three orthogonal axes.

For general purposes the following test parameters will be used. Apply a 75 g saw tooth wave shock impulse with a duration of 11 ± 2 ms in both directions of the three orthogonal axes. Measure the open circuit voltage before and after the test. Examine each sample to determine if it meets the requirements of Table 2-1 and 2-2.

APPENDIX 1. MINIMUM PERFORMANCE STANDARD FOR LITHIUM BATTERIES (continued)

For applications that have shock requirements in excess of the general test, i.e. where crash worthiness, ELT's, or survivability is an issue, the following more stringent requirements shall be used. Apply a 100 g half sine wave shock impulse with a duration of 23 ± 2 ms in both directions of the three orthogonal axes. Measure the open circuit voltage before, during and after the test. Examine each sample to determine if it meets the requirements of Table 2-1 or Table 2-2."

(4) Add the following sentence to the first paragraph after the second sentence of paragraph 2.4.1.2, **Discharge Test**: "The DC power supply shall have a voltage limit set at the number of cells per series string in the battery times the OCV of an individual cell. Add the following sentence at the end of the same paragraph: "If the sample contains one or more protective devices, the test current shall be just below (by no more than 10 percent) that at which any protective device will activate during the forced discharge test."

(5) Delete the fourth sentence of paragraph 2.4.1.3, **Forced Discharge Test**: "If the sample contains...forced discharge test. Add the following sentence at the end of the same paragraph: "This test is not required for single cell batteries."

(6). In lieu of the wording in paragraph 2.4.2.1, **Internal Short-circuit Test**, replace the first portion of the paragraph with the following:

"This test is designed to determine the effects of an internal short circuit in undischarged cells. At 24°C, deform the sample between a rod with a hard insulating surface and an insulated plate. Each cell is deformed until the open circuit voltage drops abruptly or is reduced to at least one third. At the point where the cell voltage drops, the applied force should be removed. Allow the sample to cool to 24°C and then hold for a minimum of 24 hours. Examine each sample to determine if it meets the requirements of Table 2-1."

b. Additions.

(1) Add the following sentence at the end of paragraph 1.5.11, **Design Life**: "It is the responsibility of the equipment manufacturer to assure that the integrity of date coding systems utilized by the cell/battery supplier(s) support design life criteria."

(2) Add the following sentence at the end of paragraph 1.7.3, **Lot Acceptance Test Goals**: "It is recommended that the manufacture's lot acceptance testing include the same discharge test described by paragraph 2.4.1.1."

(3) Add the following sentence at the end of paragraph 2.1.2b, **Performance Requirements**: "If the battery to be tested is required to operate in temperatures outside this envelope, the testing shall be accomplished using the more severe temperatures."

APPENDIX 1. MINIMUM PERFORMANCE STANDARD FOR LITHIUM BATTERIES (continued)

- (4) Add the following new paragraph:

2.1.9 Rated Capacity and Current

Except as otherwise specified in the test methods in subsections 2.3 and 2.4 the rated capacity and current must be the same for all testing in this standard.

- (5) Add the following new paragraph:

2.1.10 Warning - Hazards of Testing

When subjected to electrical testing specified in this document cells or batteries may leak or vent hazardous materials, burn, or in exceptional cases, vent violently.

- (6) Add the following sentence before the last sentence of paragraph 2.3.1, **Vibration Test**: "Measure the open circuit voltage before, during, and after the tests."

- (7) Add the following words to the last sentence of paragraph 2.3.3, **Temperature Cycling Test**: ", for either method."

- (8) Add the following new paragraph:

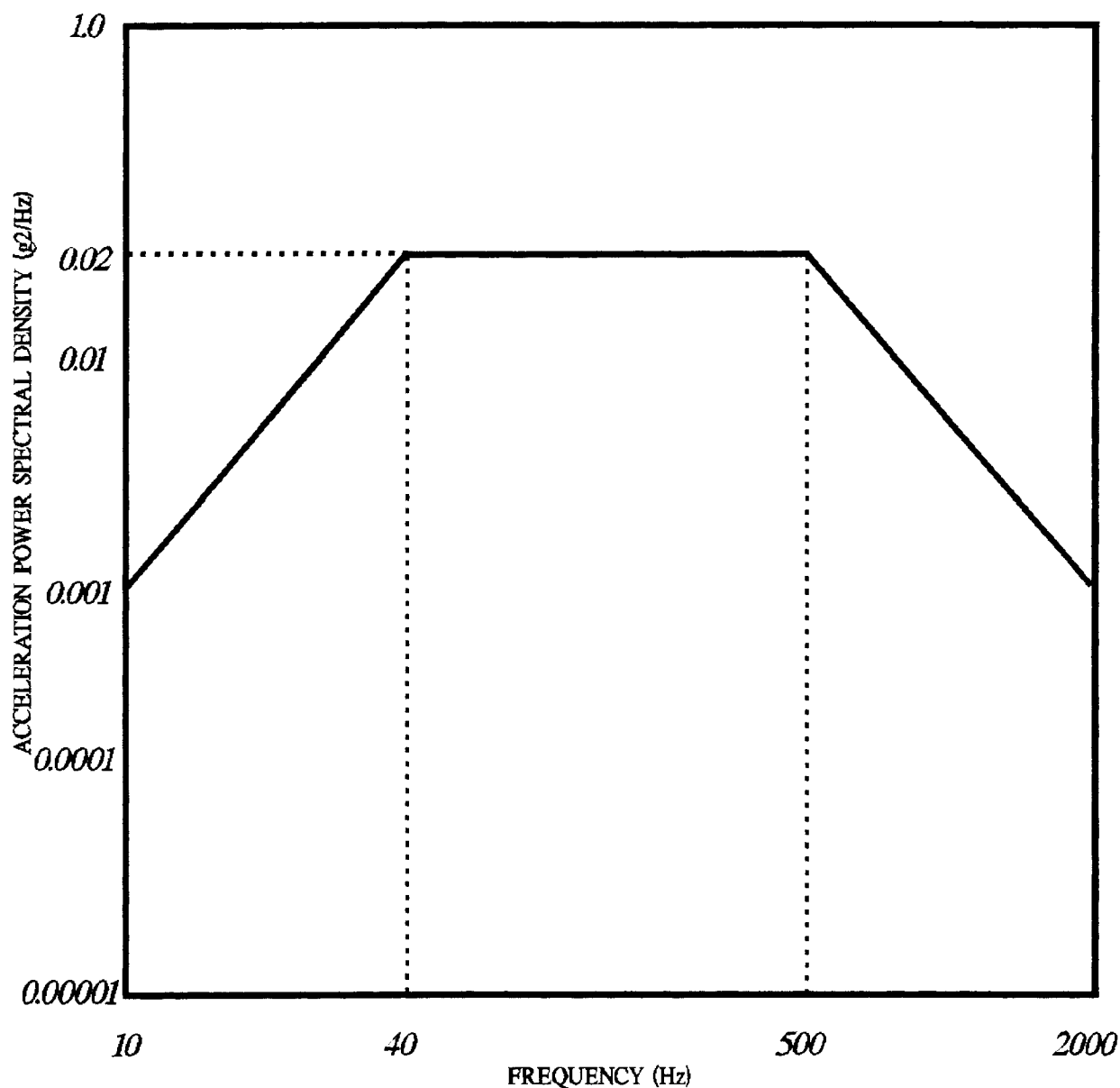
3.5 Toxic Gas Venting Precautions

Batteries that are capable of venting toxic gases shall not be installed or used in the aircraft cockpit because of an increased probability of immediate flight crew impairment.

Batteries that are capable of venting toxic gases may be installed or used in an aircraft passenger compartment if the installer shows that a safety hazard would not be created. Methods of preventing a safety hazard may include any of the following:

- a. Installing a system for overboard venting, absorption, or containment; or
- b. Showing that, if venting occurs, permissible exposure limits that are maintained by organizations such as the Occupational Safety and Health Administration and the American Conference of Governmental Industrial Hygienists, Inc. would not be exceeded.

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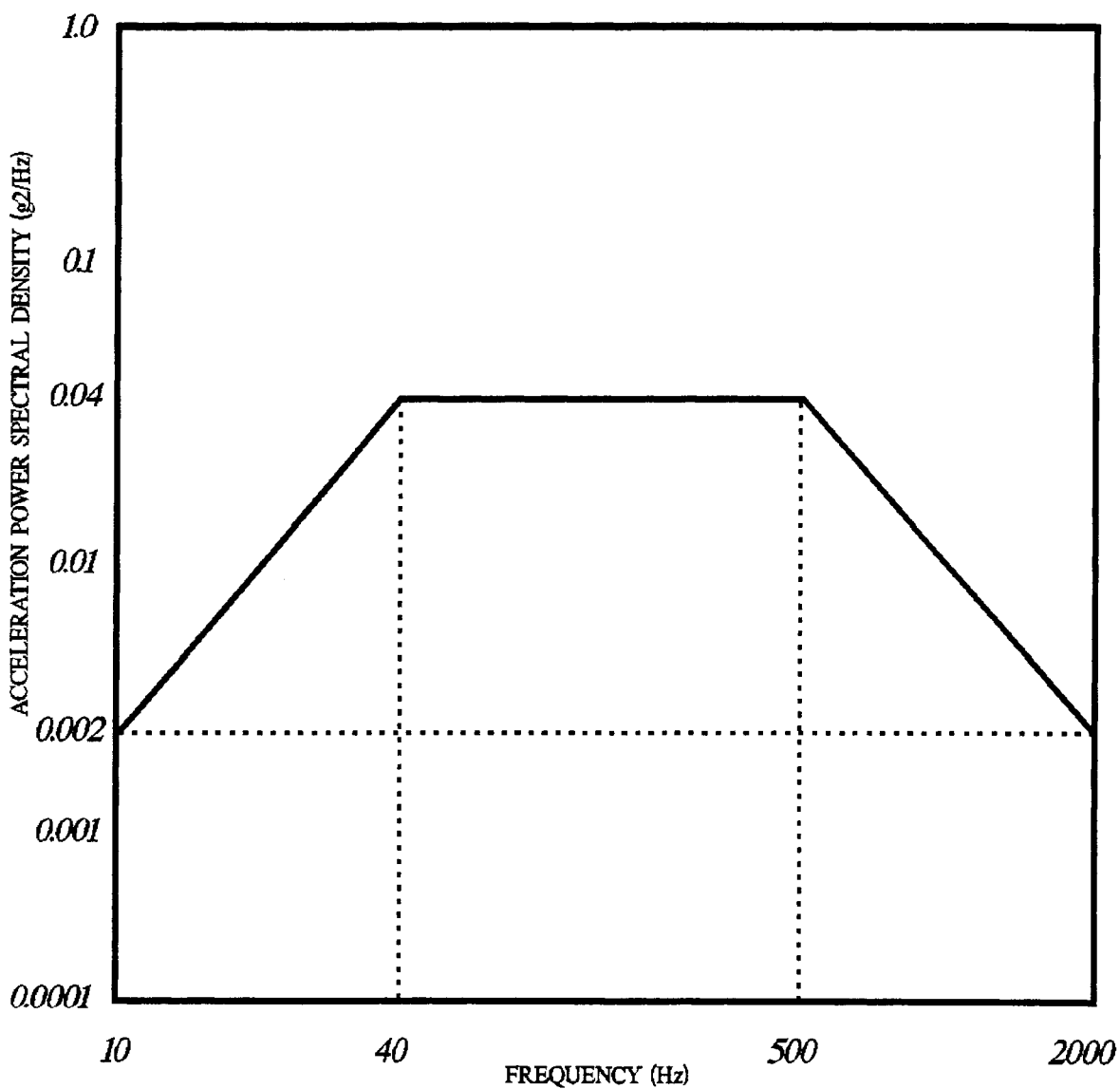


NOTE: All slopes are ± 6 dB/Octave and the cumulative spectral power density is 412 g (rms).

FIGURE 2-3

**STANDARD RANDOM VIBRATION TEST CURVES FOR EQUIPMENT
INSTALLED IN FIXED-WING AIRCRAFT WITH TURBOJET ENGINES**

APPENDIX 2. MINIMUM PERFORMANCE STANDARD
FOR LITHIUM BATTERIES (continued)



NOTE: All slopes are ± 6 dB/Octave and the cumulative spectral power density is 6.08 g (rms).

FIGURE 2-4

**ROBUST RANDOM VIBRATION TEST CURVES FOR EQUIPMENT INSTALLED
IN FIXED-WING AIRCRAFT WITH TURBOJET ENGINES**